Towards a digital dataset of the Antarctic geosphere

SCAR GeoMap project and progress

S.C. Cox¹, P. Morin²

¹ GNS Science, New Zealand   s.cox@gns.cri.nz
² PGC, University of Minnesota, USA
There are numerous, hard-copy geological maps, developed last century........
Lots of old, hard-copy geological maps, developed last century, mostly representing 'deep time'.

Poor spatial reliability.

Large areas of rock and cover deposits containing a geological/glaciological history.

Some very detailed localised maps.

Paleoclimate records based on few, spatially limited, ?representative? sites

Large quantities of NEW satellite data.
Example: McGregor & Wade (1969)
Queen Maud Mountains
1:1 million Folio Series
Commonwealth Trans-Antarctic Expedition
IGY Gunn & Warren (1962)

Morainic deposits.
Scree, stream deposits, dunes, etc.

Olivine basalt, kenyte.

Dolerite sills, dikes.
Basaltic lavas.

Tillite.

Sandstone, siltstone, conglomerate,
carbonaceous beds.

BEACON SANDSTONE
Example: Elliot et al. (1974)
Plunket Point
Reconnaissance 1:250 k Geology
Example: Elliot et al. (1974)
Plunket Point
Reconnaissance 1:250 k Geology

DESCRIPTION OF MAP UNITS

- SCREE (Qs): May also include solifluction deposits, weathered bedrock, surficial deposits
- GLACIAL DEPOSITS, UNDIVIDED (Qg): Includes undivided Qep, QTm and deposits derived from "local ice" expansion (the platform is a desert). On elevated flat surfaces may include weathered bedrock fragments and solifluction deposits.
- BEARDMORE LOW MORaine SYSTEM (Qbl): Supraglacial debris up to 10 m thick overlying bedrock. Core of the massif is characterized by angular to subrounded clasts of Beacon and angular clasts of Ferrar Dolerite.
- BEARDMORE MIDDLE MORaine SYSTEM (QTm): Supraglacial debris an ice cover of up to 20 m thick overlying bedrock. The debris is characterized by subangular to subrounded clasts of Beacon and Ferrar Dolerite.
- BEARDMORE HIGH MORaine SYSTEM (QTbh): Supraglacial debris an ice cover of up to 50 m thick overlying bedrock. The debris is characterized by subrounded clasts of Beacon and Ferrar Dolerite.
- SIRUS FORMATION (QTs): Grayish-green semi-lithified till and stratified sediments. The strata dip at an angle of 10 to 20 degrees and are characterized by stratified lenticular lenses with a maximum measured thickness of 50 m. The strata are overlain by ferriclimatic deposits of till and sheetwash. Where the contact is exposed, ferriclimatic deposits are overlain by ferriclimatic deposits.
- KIRKPATRICK BASALT (Jk): Tephra flows and pumiceous rocks from the Kirkpatrick Volcanic Center, 200 m thick. Includes sparse, thin tuff beds and tuff breccia.
WANT

Spatially accurate, holistic overview of deposits and landforms formed by the waxing and waning of Antarctica’s ice masses.

Dataset pinpointing the locations of deposits and indicating their mode of formation, age, and likely source.

Dataset to provide key underpinning information on the Antarctic geosphere and its history!

For constraining biological and ecological research, identify geoindicators of climate change, improved understanding of Antarctica’s climate role.
TAM Record of Three Glacial Systems

- EAIS
- WAIS
- Local
Legends

South Victoria Land

2 surficial units
Gunn & Warren 1962

GeoMAP 2012

> 70 units

Geology of Victoria Land between the Mawson and Mulock Glaciers, Antarctica

GEOLOGICAL REFERENCE

Quaternary

New Zealand Geological Survey

Geological Survey of New Zealand

Antarctic Glaciological Station

Legends

Surficial

Lower Tertiary

Quaternary

Geological Map of Southern Victoria Land, Antarctica

QMAP 2012

GeoMAP
Example: Simplified Traditional Display
Example: Non-traditional display utilising GIS

<table>
<thead>
<tr>
<th>Younger Deposits</th>
<th>Older (Pliocene-Miocene) Deposits</th>
</tr>
</thead>
<tbody>
<tr>
<td>supra-glacial till</td>
<td>undifferentiated till</td>
</tr>
<tr>
<td>unglaciated till</td>
<td>Ross Sea Drift 3</td>
</tr>
<tr>
<td>local glacial till</td>
<td>Valley and Wright Drift</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Long Drift</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Older Ross Sea Drift</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Vida Drift</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Bull Drift 1</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Bull Drift 2 + 3</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Joubert Till</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Asgard Till</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Phebus Till</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Prospect Formation</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Jason Glaciomarine Damission</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Inlet Drift</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Sessum_num Till</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Sirius Group</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>Other</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>unknown</td>
</tr>
<tr>
<td>till on ice sheet margins</td>
<td>basement</td>
</tr>
</tbody>
</table>

**Topographic features**
- Ice
- Sea
- Ice shelf
- Seasonal ice and water
Integrated programme to capture existing geological map data, update its spatial reliability, improve representation of glacial & cover sequences, and deliver data via web-feature services.

Proposed and accepted at SCAR 2014.

International representation solicited.

First workshop to be held in Goa at ISAES XII meeting, 12 July 2015.

More people/countries welcome!
**GOAL**

Provide a dataset aimed at cross-discipline use, or for continent-wide perspectives, using a mixed chronostratigraphic- and lithostratigraphic-based classification.

**CHALLENGE**

Collaboratively build the first modern geological dataset to classify and describe Antarctica's exposed bedrock and surficial geology.

Classify and describe around 72,000 distinct polygons that cover 51,000 km². Luckily its <0.5% of continent!
Philosophical Change

Conventional “bottom up” construction

QMAP SVL built from 72 sheets @1:50,000
**Philosophy**

“Top down” construction starting from a continent-scale, low density, attribute-poor dataset that is added to and improved through multiple iterations.

geo01 dataset (Version 1 2014) based on ADD (Version 6) rck01 polygon.
GeoMAP Process Stages 1,2

(1) Adjust rock & moraine polygons (ADD00 -> LIMA)

(2) Scan and georegister maps, build source bibliography
GeoMAP Process Stage 3

(3) Assign each polygon with map classification and source info

Unit: Kb
Name: Kirkpatrick Basalt
Source: Capponi et al. 1997b
GeoMAP Process Stage 4

(4) Legend Building

The HARDEST PART where we need local expertise, knowledge & help
GeoMAP Process Stage 5

(5) Review Glacial Geology & Cover Sequences

Integrate remote sensing, aerial photos, detailed local studies, to improve precision of regional geology and improve depiction of glacial sequences.

Improve classification of age, composition and source of tills and other surficial deposits.
By Source

- Local glacier
- EAIS
- WAIS

(5) Review
Glacial Geology & Cover Sequences

CODE & UNIT
- QTm - Quaternary-Tertiary glacials
- Czv - Quat.-Miocene volcanics
- DJ - Jurassic Ferrar Gp & Dev.-Perm. Beacon S.grp
- Pal - Mes.-Paleozoic granitoid & metamorphics

AGE

- Colluvium
- Scree
- Local alpine & valley glacier tills
- Ice sheet margin tills
- Ross Ice sheet tills
- Lake, coastal and marine deposits

COLDER DRY-BASED GLACIERS

WARMER WET-BASED GLACIERS
Towards a digital representation of the Antarctic geosphere: classification of exposed rock and sediment outcrops

GeoMAP Process Stages 6, 7

(6) Assign polygons with information using GeoSciML standard

(7) Develop unified legend and coding into seamless continent-wide dataset, (peer review, checking)

Version 1.1 in 2019?
~35% of outcrops now have some form of digital representation ≥Stage 4 suitable for use at 1:250,000 scale
GeoMAP: Like a spatial Wikipedia of the exposed Antarctic geosphere

**Uses:** interpretation of sub-ice geology, source characterisation of tills, ice modelling, exploration for geoinicators of climate change, biological and ecological studies, ?????? (and maybe even geology!)

**Help Us!** The GeoMap team welcomes anyone interested in capturing their geological or geomorphological data, or historical data, from a particular region.

Visit the S20 posters in Ballroom 2 @ 14:00
Contact: s.cox@gns.cri.nz